

# **Nevada DOT Cold In-Place Recycling**

Federal Highway Administration National Review

Close out meeting, August 25, 2005

## **Purpose**

The purpose of this review is to capture for technical deployment the most advanced uses of Cold-In-Place recycling (CIR) and then transfer the knowledge to all State Transportation Agencies (STA). Through this sharing of information, we intend to showcase how other STA overcame barriers and advanced the routine use of CIR as a pavement rehabilitation strategy. “Best Practices” will be identified along with barriers and benefits. Specifications, construction practices, implementation challenges, and identification of ongoing and completed research will also be documented. This information will then be disseminated to all STA through technical guidance, training, and guide specifications, as necessary.

## **General**

- NDOT has used CIR successfully for over 20 years. The use of CIR and Full Depth Reclamation (FDR) instead of conventional reconstruction strategies has allowed NDOT to save over \$600 million dollars while providing longer lasting pavements. NDOT has improved their systems’ pavement condition significantly without spending more money, minimizing traffic interruptions during construction, and preserving natural resources.
- NDOT has effectively Cold In-place Recycled 770 centerline miles or 11% of its system since 1997.
- Prior to 1997, NDOT completed 118 centerline miles of CIR. A total of six projects were recycled from 1985 to 1992. Three of these projects received a chip seal wearing surface and the remaining three received a 2 ½” overlay.
- NDOT recommends CIR if there are functional deficiencies (non-load related cracking) when the pavement is structurally sound.
- NDOT uses a general rule-of-thumb that the existing structural section must be the minimum depth of the intended CIR layer plus 1½”.
- Pavement rehabilitation type selection is based on an engineering evaluation that begins with Pavement Management System (PMS) data analysis. The age of the pavement in addition to the predominant stresses are evaluated. From this a list of proposed projects is produced and sent to NDOT districts for their identification of other projects needs. The 3R review team, which includes materials, roadway design, and field construction representatives, conduct an on-site review of each project to develop project scope. Utilizing this process has allowed NDOT to implement strategies that are more cost effective than overlay, mill and overlay, or reconstruction. NDOT has documented \$600

million in savings, over the last 20 years, utilizing CIR and FDR as rehabilitation strategies as selected by this process.

- NDOT typically cold in place recycles three inches (3"). A structural overlay is required for roadways with greater than 300,000 ESALs. For comprehensive list of various surface course recommendations, please refer to NDOT's design table.
- NDOT does not perform laboratory mix design testing for CIR projects. Based on the large amount of experience with CIR and research performed by the University of Nevada, Reno (UNR), NDOT uses both CMS-2S and lime at the rate of 1.5% by mass of milled material for quantity purposes on all CIR projects. Field adjustments are made for the emulsion content based on the experience of knowledgeable contractor field personnel with concurrence of the project engineer. Typically, field application rates of CMS-2S are 1.0% to 1.5% by mass of material.
- NDOT has established a standard structural layer coefficient of 0.28 for the CIR layer. These values are based on NDOT's field performance, back calculations of resilient modulus values from FWD testing.
- CIR is a standard tool, utilized within NDOT's proactive preventive maintenance program, to get the best performance from their existing pavements. Combination of proactive PMS program and CIR resulted in NDOT to save over \$40M annually.
- Equipment trains utilized by CIR contractors in Nevada have up-cut milling heads, pugmills, and utilize the general contractor paving crew as standard practice.

## **Best Practices**

- Once Nevada adopted CIR as standard practice, they have moved ahead to test the limits of CIR to raise the bar.
- NDOT considers CIR material as an "asphalt treated base" rather than hot mix, and treats it as such.
- Ride specifications are required, using a California type Profilograph, with target value of 5" per mile with a hot mix asphalt (HMA) overlay or 10" per mile without HMA overlay.
- NDOT is committed to a strong partnership with all parties involved in CIR and builds on this through constant communication:
  - The success of CIR in Nevada would have not been possible without a strong partnership between CIR contractors, general contractors, suppliers, and both NDOT's central office and district staff.
  - NDOT had meetings with local contractors to inform them of the intent of the specifications prior to adopting CIR.

- In addition, an annual meeting was used to discuss the lessons learned from construction projects. Agency field personnel as well as prime and sub-contractors attend these meetings to discuss improvements for future projects.
- NDOT requires a mandatory 2-hour workshop for all personnel involved with CIR project. A Materials Division and Construction Division representative, using a checklist, review the project scope of work, item by item, at this meeting. Both contractor and NDOT staff can subsequently use this checklist.
- The addition of lime slurry has improved the performance of CIR by:
  - Improving moisture sensitivity,
  - Creating a more uniform material,
  - Helping the emulsion to break sooner which allows the roadway to be opened to traffic sooner,
  - Absorbing excess water, and
  - Improving the bond between the CIR layer and the existing underlying pavement.

These findings were verified by laboratory testing conducted by UNR.

- NDOT has end-product specifications that allow the contractor to do field quality control and adjust the mix emulsion content. CIR contractors are specialist and know what is needed to provide a quality product. NDOT requires the contractor to overlay the cold in-place layer after a minimum of 10 and maximum of 45 days curing. If problems exist, they usually appear within 24-48 hours after the CIR mat is opened to traffic.
- NDOT establishes relative density, for optimum compaction, by conducting a 1000' test strip during the first day of production. A relative density of 98%, as determined by a thin-lift density gauge, is used for target field density. Any individual field test may not be less than 95%. Re-compaction (re-rolling) with pneumatic and steel rollers, after 3-15 days may increase the density by as much as 2%-3%.
- Equipment calibration prior to production on each project ensures proper application rates of materials, i.e. emulsion, lime, and aggregate weight pulled off the belt scale.
- NDOT is continuously monitoring all of their CIR projects, and incorporating the data into a database that currently resides at UNR and NDOT Materials Division.
- NDOT's annual project list is available for contractors to anticipate how many CIR will be advertised on monthly basis. Contractors appreciate this, and consider it a very reliable list.

## **Barriers Overcome**

- NDOT anticipates encountering soft subgrade and plans for it. It is repaired by, excavating 14” of the in-place materials, replacing it with 12” aggregate base, and 2” of premixed bituminous surfacing as a temporary patch until dense graded plant mix becomes available. Use of a cold mix pile on the job site precludes the contractor from having to mobilize a HMA plant for small quantities of materials.
- The CIR layer should receive a structural overlay rather than chip seal surface treatment when traffic is greater than 400 ADT.
- NDOT has encountered non-uniform depth of existing pavements so they now take core samples across the entire width of the pavement to ensure structural section depth to better control the removal depth.
- A key barrier was the lack of knowledge concerning performance characteristics, and CIR production processes. It was overcome through partnership with contractors, and by emphasizing training.

### **Current Barriers/Issues**

- A limited number of CIR contractors in the western part of the US cause scheduling conflicts in multiple states. CIR sub-contractors could dictate to general contractors when to be on the job because of scheduling conflicts.
- CIR is more of an art rather than science.
- Contractors have difficulty maintaining qualified operators. The building boom currently in the west has negatively affected the availability of labor and materials.
- Even with 20 years of experience, some NDOT and contract staff are still reluctant to use CIR.
- Counties and cities have little experience with CIR because consultants that do the majority of their designs are averse to the risks associated with CIR. Some counties also have issue concerning funding that limit the use of CIR.
- Likely candidate projects that require nighttime construction cannot use this technology because of temperature concerns.
- Curing time limits CIR in urban areas.
- Industry identified serious concerns over the constant change of personnel within DOT's in the west. These changes have made it difficult to establish and maintain working relationships and partnerships with states. Some of these states treat CIR as an experimental process even though they themselves had been doing it for nearly two

decades. Industry appreciates stability that NDOT has provided enabling them to better plan for future projects.

- There have been few instances of new CIR contractors. Industry has identified the following barriers which are not necessarily bad from a quality perspective:
  - Specifications requiring equipment calibration,
  - Specification that place the responsibility on the contractor, and
  - Failure is not an option because one failure affects the entire industry.

### **Follow up**

- NDOT will be completing a product evaluation using “Reflex” and “PASS” as substitute for CMS-2S binder currently required on all projects. NDOT would like to learn of experiences from other states using different binders. Ideally they seek a binder that would allow them to compact the pavement directly behind the paver and open the section to traffic sooner. This could expand the CIR program considerably.
- NDOT has recently used CIR for a 12 lane-mile of I-80. This section has 40% trucks and 7000 ADT with six (6) percent grade. Performance characteristics of this section are being closely monitored, and it will be reported.